GLASS TOUCH PANEL WITH ADHESIVE HAVING HYGROSCOPIC FINE PARTICLES

FIELD OF THE INVENTION

[0001] The present invention relates to a glass touch panel, and more particularly, to a novel glass touch panel of a glass/glass type which is excellent in terms of high temperature and high humidity resistance, and also has merit of a narrow frame, and thus is useful for various kinds of displays such as a car navigation display, a video camera display and a monitoring display.

BACKGROUND OF THE INVENTION

[0002] There has often been used a touch panel for various kinds of displays such as a CRT display. The touch panel is capable of inputting information by using a fingertip or a pen.

[0003] A basic structure of the touch panel has a glass substrate, a transparent resin substrate above the glass substrate, and conductive films on surfaces of the glass substrate and the transparent resin substrate opposing each other. Also, spacers are optionally used between the glass substrate and the resin substrate.

[0004] However, the touch panel having such basic structure has been not always been satisfactory in terms of durability, environment resistance and wear resistance. Further, clearness of a screen has not been satisfactory, and aging discoloration of the screen has been remarkable.

[0005] In view of these problems, there has been invented a glass touch panel (refer to JP1997-146707) capable of realizing excellent durability, environment resistance and wear resistance, and also a beautiful screen exhibiting less discoloration and color shading. As shown in Fig.1, this glass touch panel has a pair of transparent substrates 1a,1b, each having transparent conductive films 2a,2b, opposed to each other, at surfaces of the transparent

substrates, wherein upper transparent substrate 1a, as a touch input portion, is a glass substrate as is lower transparent substrate 1b. The glass touch panel also has extended wiring 4, a bonding member 5 and a silver electrode 7.

[0006] However, this prior art glass touch panel, having such distinctive features, still needs to be improved much more in terms of temperature and humidity resistance in order to meet severe demands of various industries relating to displays. For example, as a display of a navigation system for automobiles and such, high temperature and high humidity resistance is required as much as possible.

SUMMARY OF THE INVENTION

[0007] In view of the above, it is a main object of the present invention to provide a novel glass touch panel having beneficial features such as excellent durability, environment resistance and wear resistance, a beautiful screen exhibiting less discoloration and color shading, as well as having excellent high temperature and high humidity resistance as compared with the prior art glass touch panel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The foregoing and other objects, features and advantages of the present invention will be better understood from the following detailed description, taken in conjunction with the accompanying drawings, in which:

[0009] Fig. 1 is a cross-sectional view showing a prior art glass touch panel.

[0010] Fig. 2 is a cross-sectional view showing one example of a glass touch panel of the present invention.

[0011] Fig. 3 is a cross-sectional view showing another example of the glass touch panel of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[Adhesive blended with hygroscopic fine particles]

[0012] A glass touch panel of the present invention is a touch panel of a glass/glass type and is different from a conventional glass touch panel in a manner of bonding of upper transparent glass substrate 1a and lower transparent glass substrate 1b as shown in Figs. 2 and 3.

[0013] As shown in Figs. 2 and 3, the glass touch panel of the present invention has upper transparent glass substrate 1a and lower transparent glass substrate 1b, each having a respective transparent conductive film 2a, 2b, and being opposed to each other. The glass touch panel as shown in Fig. 3 also has superfine particle dot spacers 3 on the transparent conductive film 2b of the lower transparent glass substrate 1b. The transparent conductive films 2a, 2b may be disposed in a suitably shaped pattern.

[0014] Then, in the present invention, the upper transparent glass substrate 1a and the lower transparent glass substrate 1b are bonded and secured to each other by use of an adhesive 6 mixed with hygroscopic fine particles, which are fine particles having hygroscopicity.

[0015] Therefore, since the hygroscopic fine particles in the adhesive 6 absorb moisture effectively, a humidity resistant property much better than that of the conventional panel can be attained even in an extremely high temperature condition. As has already been described, a high temperature and high humidity resistant property is extremely important for use in a highly humid condition, and therefore, the glass touch panel of this invention can be used more preferably for a display of a navigation system inside of an automobile, and the like, for example.

[0016] The hygroscopic fine particles must exhibit full hygroscopic features even in the adhesive 6. For example, fine silica-type particles having hygroscopic properties can be used preferably as such particles. A size of the

hygroscopic fine particles should not be limited in any way as long as they exhibit high temperature and high humidity resistant properties while adhesiveness of the adhesive 6 is maintained. However, from a viewpoint of realization of still more effective co-existence of adhesiveness and high temperature and high humidity resistance, for example, a diameter of at most 50μm is preferable, a diameter of 5 to 50μm is more preferable, and further a diameter of 5 to 10μm is much more preferable. As for a mixing amount, although there is naturally a relationship with diameter, it should not be limited in any way as long as the particles exhibit high temperature and high humidity resistant properties and allow an adhesive property of the adhesive 6 to be maintained at the same time. However, for still more effective co-existence of both properties, it is preferable to mix the particles with a weight ratio of at most 10%, and more preferable with a weight ratio of at most 5% .

[Silver Electrode blended with glass fiber]

[0017] As shown in Figs 2 and 3, in the glass touch panel of this invention, it is also preferable to use a silver electrode 7 mixed with a glass fiber. The silver electrode 7 is disposed at a predetermined position of an outer periphery of the upper transparent conductive film 2a and the lower transparent conductive film 2b.

[0018] This silver electrode 7 mixed with a glass fiber can maintain a gap between the upper transparent conductive film 2a and the lower transparent conductive film 2b very reliably, thereby realizing excellent smoothness while also preventing screen distortion and unevenness of image quality, as well as interference infringement, much more effectively than does the conventional glass touch panel.

[0019] From a viewpoint of realizing sill more effective smoothness, it is preferable to mix the glass fiber into the silver electrode 7 with a weight ratio of at most 10%, and also to use a silver paste having an electric resistivity of at most

5.0×10^{-4} Ωcm for the silver electrode 7.

[Performance and Characteristics of Glass Touch Panel]

[0020] Additionally, the glass tough panel of the present invention as described above should have the following required performance and characteristics. Of course, the glass touch panel of the invention can easily achieve such high performance and characteristics.

[0021] Among all, light transmittance should be extremely favorable. That is, a light transmittance of at least 85% is preferable and 90% is more preferable. Such high transmittance can provide a beautiful screen.

[0022] Next, an operation temperature should preferably be −30 to 65°C under a condition of at most 90%RH, and a preservation temperature of the condition with no dewing should preferably be −40 to 85°C (12 hours) under a condition of 95%RH. Further, as for humidity resistance, the glass touch panel should attain 1000 hours of use under a condition of 60°C, 95%RH. Furthermore, the glass touch panel should maintain heat resistance at 85°C and cold resistance at −30°C.

[0023] As for mechanical characteristics, the glass touch panel should generally have an operation load of 10 to 200 g when a switch enters into a conduction state by pressing the upper transparent glass substrate 1a with a test rod having its top end having a radius of curvature of 4 mm, diameter of 8 mm and hardness of 60°. A surface hardness should be 5 to 7 Mohs hardness.

[0024] Referring to a heat cycle as a durability index, the glass touch panel should operate over 200 cycles, one cycle comprising consecutive procedures of leaving it for one hour in an atmosphere of −30°C and then leaving it for one half hour at a room temperature (or normal temperature), further leaving it for one hour in an atmosphere of +85°C, and then leaving it for one half hour at a room temperature (or normal temperature).

[0025] In addition, an inactivation gas or air may be injected just before

sealing in order to prevent occurrence of interference fringes as well as to smooth recovery of glass (so called bounce) after input. Further, an operation load may be controlled by measuring it with a tension gauge in order to make sure it is suited for various purposes. In this case, for example, it is preferable to make the bounce at most 10 msec for an ordinary operational method using a finger.

[0026] From a viewpoint of material for the panel, borosilicate glass or soda glass having a thickness of from 0.15 mm to 0.3 mm may preferably be used for the upper transparent glass substrate 1a. And, for example, upper transparent glass substrate 1a of borosilicate glass may preferably have physical properties as in the following Table 1.

Table 1
[Physical properties of the upper glass substrate]

Heat expansion coefficient (0 to 300°C)	70 to 80 × 10^{-7}/°C
Young's modulus	7 to 8 × 10^{3} kg/mm^{2}
Poison ratio	0.20 to 0.24
Knoop hardness	590 to 615 KHN_{100}
Density	2.30 to 2.85
Distortion point	480 to 520°C
Gradual cooling point	520 to 580°C
Softening point	700 to 750°C
Volume resistivity	8 to 10 log ρΩ cm
Dielectric characteristic (1 Mhz, at 20°C)	
Dielectric constant	6 to 8
Loss	0.2 to 0.6
Refractive index	1.5 to 1.54

[0027] Commercial products can be used for such glass having the above properties.

[0028] As for the lower transparent glass substrate 1b, soda glass having a thickness of from 0.5 mm to 3.0 mm may preferably be used.

[0029] Further, as for the transparent conductive films 2a, 2b disposed on such glasses 1a, 1b, thin films of ITO, tin oxide and the like, especially, those

formed by sputtering and chemical vapor deposition (CVD) may preferably be used. ITO may also be vapor-deposited on a deposition of SiO_2 and the like. This vapor deposition is a preferred method with regard to an adhesion property and uniformity property of the film.

[0030] In a case where the superfine particle dot spacers 3 are disposed as shown in Fig. 3, it is preferable to use a spacer formed from a thermosetting resin and having a diameter of from 20 to 100 μm, a height (i.e. dot thickness) of from 3 to 6 μm, and an inter-dot pitch of from 2 to 4 mm.

[0031] Electrical properties of a touch panel may preferably be as shown in the following Table 2.

Table 2
[Electrical properties of the glass touch panel]

Rating	DC 5V, 50 mA or less
Insulation resistance	DC 25V, 10 MΩ or more (between upper and lower electrodes)
Linearity	± 3.5% or less
Bounce	10 msec or less (by ordinary finger operation)
Antistatic voltage withstanding	15 kV or higher
Dynamic range	Lower limit: 0 to 0.7V, Upper limit: 5 to 4.6 V

[Method of manufacturing the glass touch panel]

[0032] Hereinafter, a method for manufacturing the glass touch panel of this invention will be explained. For example, the glass touch panel of Fig. 3 can be manufactured according to steps [1] to [6] described below.

[0033] Step 1. Formation of transparent conductive films 2a, 2b of ITO onto transparent glass substrates 1a, 1b by performing sputtering and CVD.

[0034] Step 2. Patterning of the transparent conductive films 2a, 2b by performing resist ink printing, film etching and resist ink peeling, or by performing photo-lithography.

[0035] Step 3. Formation of super-fine particle dot spacers 3 by

performing resist ink printing and thermosetting, or by performing photo-lithography.

[0036] Step 4. Formation of silver electrode 7 by performing glass fiber mixing, silver paste printing and baking.

[0037] Step 5. Printing of adhesive 6 by performing hygroscopic fine particles mixing, printing and temporal baking, or by performing photo-lithography.

[0038] Step 6. Bonding of transparent glass substrates 1a, 1b to each other.

[0039] The glass touch panel of this invention to be provided by the above manufacturing steps has excellent high temperature and high humidity resistance due to the adhesive 6 being blended with hygroscopic fine particles, and also has excellent smoothness due to the silver electrode 7 being blended with glass fibers, thereby realizing characteristics of freeness from screen distortion, image-quality unevenness, and interference infringement, and also of extremely little discoloration and aging change of a screen.

[0040] It is preferable that the adhesive 6 blended with the hygroscopic fine particles is used as a thermosetting or room-temperature epoxy-type sealant, or a UV setting acrylic-type sealant. For a thermosetting sealant, temporal baking is needed, and for a UV setting sealant, UV irradiation is needed. As already described, the hygroscopic fine particles must allow these sealants to exhibit high temperature and high humidity resistance in these sealants while maintaining an adhesive property.

[0041] Of course, the glass touch panel of Fig. 2, having excellent high temperature and high humidity resistance, and excellent smoothness, can be manufactured as well by above steps 1, 2, 4, 5 and 6, excluding step 3.

[Example]

[0042] A glass touch panel as shown in Fig.3 was actually manufactured by

the following steps 1 to 6. Main dimensions of the glass touch panel are shown in Table 3.

Table 3 [Main dimensions of the panel]	
Upper transparent glass substrate 1a:	0.2 mm thickness
Lower transparent glass substrate 1b:	1.1 mm thickness
Outer size:	140 × 85 mm
Operational area size:	130 × 59 mm

[0043] Step 1. Formation of ITO thin film

[0044] At first, transparent zinc borosilicate glass is adopted as upper transparent glass substrate 1a and soda glass is adopted for lower transparent glass substrate 1b, and ITO thin films having a film thickness of from 100 to 200 Å and a surface resistance of 500 Ω/□ (ohms per square) are formed as transparent conductive films 2a, 2b by performing sputtering and CVD. Transparent zinc borosilicate glass and soda glass commercially available as substrates for a thin film were used.

[0045] Step 2. ITO patterning

[0046] Next, the following treatments are conducted sequentially for ITO patterning.

- Pre-cleaning by applying supersonic waves
- Coating of resist ink by performing screen printing
- Baking at 120°C for 30 min.
- Etching of ITO with nitrate
- Peeling of the resist ink by using an alkali
- Post cleaning by applying supersonic waves

[0047] Step 3. Formation of superfine particle dot spacers 3

[0048] Next, the following treatments are conducted sequentially for

formation of superfine particle dot spacers.

- Coating of thermosetting resist-ink by printing with a metal mask
- Baking at 200°C for 60 min. so as to obtain a dot diameter of 20 μm, a dot thickness of 5 μm and a dot pitch of 3 mm

[0049] Step 4. Formation of silver electrode 7

[0050] Next, the following treatments are conducted sequentially for formation of a silver electrode.

- Stirring of glass fiber in silver paste with a weight ratio of 1.2%
- Printing of the silver paste
- Baking at 180°C for about 60 min.

[0051] Step 5. Printing of thermosetting epoxy-type sealant as adhesive 6

[0052] Next, the following treatments are conducted for printing of a thermosetting epoxy-type sealant.

- Stirring of silica-type fine particles having a diameter of 10 μm and a weight ratio of 2.5%
- Seal printing by using a thermosetting epoxy-type sealant
- Temporal Baking at 90°C for about 30 min.

[0053] Step 6. Bonding

[0054] As the final step, the upper transparent glass substrate 1a and the lower transparent glass substrate 1b are bonded together by performing the following procedures.

- Bonding by coating a minute amount of the silver paste onto contact points
- Setting in a curing jig
- Baking at 150°C for about 90 min. and cooling gradually
- Cutting
- Injection of air
- Sealing by UV adhesive

[0055] By performing the above manufacturing steps, a glass touch panel having the following performances and characteristics as shown in Table 4 was

obtained.

Table 4 [Performances and Characteristics]	
Driving system	Analog system
Writing method	Finger or pen
Light transmittance	85% (550nm)
Operation temperature	-30 to 65°C (90% RH or less)
Humidity resistance	1000 hours (60°C -95% RH)
Heat cycle	250 cycle (-30°C, +85°C)
Heat resistance	85°C
Operation load	80g
Surface Mohs hardness	6
Rating	0.8 mA (DC 5V)
Insulation resistance	12 MΩ (DC 25V)
Linearity	+ 2.0%
Bounce	8 msec

[0056] For comparison, a prior art glass touch panel was manufactured by performing the steps disclosed in JP1997-146707, and its performances and characteristics are shown in Table 5. This prior art panel has the same outer size and operational area size as the above panel of this invention, which are 140 × 85 mm and 130 × 59 mm, respectively.

Table 5 [Performances and Characteristics]	
Driving system	Analog system
Writing method	Finger or pen
Light transmittance	85% (550nm)
Operation temperature	-10 to 60°C (90% RH or less)
Humidity resistance	140 hours (60°C -95% RH)
Heat cycle	15 cycle (-30°C, +80°C)
Heat resistance	83°C
Operation load	100g

Surface Mohs hardness	6
Rating	0.8 mA (DC 5V)
Insulation resistance	12 MΩ (DC 25V)
Linearity	+ 3.0%
Bounce	8 msec

[0057] As is apparent from Tables 4 and 5, the glass touch panel of this invention is excellent in terms of operation temperature, humidity resistance, heat cycle and heat resistance as compared with the prior art glass touch panel. Consequently, a glass touch panel having an extremely improved environmental resistance is realized, and such panel is very suitable to an inner environment of a vehicle. It is needless to say that this panel is suitable not only for inside a car, but also for various situations at high temperature and high humidity. Of course, the panel thus made is free from distortion, unevenness and interference fringes on a screen, and exhibits good image quality.

[0058] As described above in detail, the invention can provide a novel glass touch panel having excellent characteristics in terms of durability, operableness, freeness of design and input accuracy, as well as being excellent in terms of high temperature and high humidity resistance, and also in terms of smoothness, as compared with prior art glass touch panels.